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DEPARTMENT OF MINES AND AGRICULTURE.

MEMOIRS OF THE GEOLOGICAL SURVEY OF NEW SOUTH WALES.

E. F. PITTMAN, A.R.S.M., GOVERNMENT GEOLOGIST.

PALÆONTOLOGY, No. 10.

THE FOSSIL FISHES

OF THE

HAWKESBURY SERIES AT ST. PETER'S.

BY

ARTHUR SMITH WOODWARD, LL.D., F.R.S.

Keeper of Geology in The British Museum.

SYDNEY : W. A. GULLICK, GOVERNMENT PRINTER.

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LETTER OF TRANSMITTAL.

Geological Survey of New South Wales,
Department of Mines and Agriculture,
Sydney, 10 October, 1907.

Sir,

I have the honour to submit for publication Memoir No. 10, of the *Palæontological Series*, on the *Fossil Fishes of the Hawkesbury Series at St. Peter's*, by Dr. A. S. Woodward, LL.D., F.R.S., of the British Museum.

The Department is deeply indebted to Dr. Woodward for the time and skill which he has devoted to the study of our fossil fishes. The fossils which are described in this Memoir were collected by Mr. B. Dunstan, Acting Government Geologist of Queensland, who formerly occupied the position of Lecturer in Geology and Mineralogy at the Technical College, Sydney.

Dr. Woodward's determinations are of peculiar geological interest in this instance, inasmuch as they indicate the survival, in this part of the world, of several Permo-Carboniferous genera of fishes in Triassic times.

I have the honor to be,

Sir,

Your obedient servant,

EDWARD F. PITTMAN,

Government Geologist.

THE HON. JOHN PERRY, M.P.,

Minister for Mines and Agriculture.

I.—INTRODUCTION.

THE fish-remains obtained by Mr. Dunstan from the Hawkesbury Formation at St. Peter's belong to two distinct series, which are described separately in the following Memoir. The first, and much the largest, series was discovered in a dark indurated shale, which splits with a more or less irregular fracture; while the second series was found in a grey mudstone, closely resembling that in which numerous fishes occur at Gosford. The skeletal parts of the fishes in the first series are actually preserved, though considerably stained and partly obscured by the oxides of iron and manganese, with some pyrites; while many of the small cavities in these fossils are filled with calcite. The fishes of the second series occur chiefly as impressions on the rock, which are stained black with a thin film of bituminous material resulting from the decomposition of the original organic tissues. In both cases the fishes appear to have been complete when buried, and show no signs of having been disturbed by currents or by predaceous animals. Like most well-preserved fossil fishes, they probably denote some local accident which suddenly destroyed and entombed them.

All measurements are given in decimal fractions of the metre.

II.—DESCRIPTION OF THE GENERA AND SPECIES.

A. From Dark Indurated Shale.

Subclass—**ELASMOBRANCHII.**

Order—**ICHTHYOTOMI.**

Family—**PLEURACANTHIDÆ.**

Genus—**PLEURACANTHUS**, *Agassiz*, 1837.

(*Poiss. Foss.*, iii, p. 66.)

Gen. Char.—Teeth with thick depressed root, the crown consisting of two principal divergent cones, generally of unequal size, with a more or less minute intermediate denticle. A bilaterally-symmetrical spine, armed with two longitudinal series of recurved denticles, inserted at the back of the head. A single extended dorsal fin, separate from the diphycecal caudal fin; two small anal fins. No shagreen or other dermal armour.

Obs.—This typically Upper Palæozoic shark has not hitherto been found in the Southern Hemisphere. It occurs in the Carboniferous and Lower Permian of Europe, and in the Coal Measures of North America. Identical teeth have also been discovered in the Upper Trias (*Keuper*) of England.

PLEURACANTHUS PARVIDENS, *sp. nov.*

Plate I.

Obs.—The remains of this species are in a remarkable state of preservation, and the type specimen is the largest nearly complete skeleton of a *Pleuracanth* hitherto discovered. The most important examples for description are the following :—

- (a) Nearly complete fish, 1·43 m. in length, with traces of the dentition, but with the spine only partly shown in impression; to be regarded as the type specimen (Pl. I, Fig. 1).

- (b) Imperfect jaws, with hyoid arch and part of the pectoral girdle (Pl. I, Fig. 2).
- (c) Portion of head and dentition.
- (d) Portions of jaws with teeth (Pl. I, Fig. 3).
- (e) Group of teeth (Pl. I, Figs. 4, 5).
- (f) Fragment of abdominal region (Pl. I, Fig. 6).
- (g) Imperfect pectoral fin (Pl. I, Fig. 7).
- (h) Imperfect pair of pectoral fins (Pl. I, Fig. 8).

Sp. Char.—Length of head probably nearly equal to the maximum depth of the trunk, which is contained about six times in the total length of the fish. Teeth relatively much smaller than in the type species; the principal cones of the dental crown round and smooth, with a long and slender, straight intermediate denticle.

General Form.—As suggested by the displacement of the vertebral axis, the type specimen appears to be slightly deepened by crushing in the anterior part of the abdominal region; but this fossil seems to justify the statement of proportions given in the specific diagnosis. The fish must have been laterally compressed, and the caudal region is comparatively slender. As shown by No. c, the snout is bluntly rounded.

Head and Dentition.—The cartilages of the head exhibit excessive calcification, as usual, in small tesserae, and portions of them are thus well preserved though crushed. In the type specimen they are unfortunately too much broken to display any outlines; but parts of the jaws are seen in Nos. b, c. The mandible especially (Pl. I, Fig. 2, *ml.*) is shown to be long and slender, without much deepening at the hinder end; and the dentition (*l.*) cannot have extended backwards beyond its middle point. The teeth are always badly preserved—in section, in cast, or partially encrusted with mineral matter,—but it is clear that they were unusually small for *Pleuracanthus*. As shown in Pl. I, Fig. 2*a*, the dental arrangement is in numerous, very close transverse series, of which some comprise at least fourteen teeth, deeply overlapping in the ordinary manner. In this figure they are displayed partly in section, partly as hollow moulds; in specimen *d*, chiefly in section but partly from the outer face; while in the fragment marked *e*, they are scattered and display various aspects, but are partly obscured by encrusting mineral matter. The expanded bases which are seen from beneath

(Fig. 4) are elongate-oval in shape, the pointed end being directed inwards, while the outer blunt end bears the usual "button" for articulation with the next outer tooth which it overlaps. The two principal cones of the dental crown (Figs. 3, 5) are round in section, gently incurved, and apparently smooth. They are hollow and easily broken, and fractured surfaces impart to some specimens the false appearance of vertical ribbing. Between the principal cusps there is a long and slender, straight denticle, which is also hollow and often broken.

Branchial Arches.—As usual in *Pleuracanthus*, the branchial arches bear well-developed cartilaginous rays for the support of the gills. Some of these are well shown behind and below the mandible in Pl. I, Fig. 2, where the smaller and more delicate rays ($g.^1$) probably belong to the ceratohyal, while a stouter series ($g.^2$) must be referred to the first branchial arch. The middle members of the latter series are shown as branching, but it is uncertain whether this is not a false appearance due to displacements during fossilisation.

Vertebral Axis.—The persistent character of the notochord is clearly indicated in the type specimen (Pl. I, Fig. 1), in which the hæmal arches are probably a little displaced downwards by crushing. The arches themselves are all well calcified in tesseræ, though the small hollow frequently seen in the middle of both neural and hæmal elements proves that this calcification did not penetrate quite to the centre of the cartilage. Seven comparatively stout and forwardly inclined neural arches are shown in advance of the remains of the pectoral girdle, while appearances in the hinder four of these arches suggest that the neural spine ($s.$) is a separate element and as long as the supporting pair of laminae. There cannot be more than one additional arch of this series covered by the upper end of the scapula, and then the normal series of backwardly-inclined, slender neural arches begins. These arches do not diminish in height until the caudal region is reached, and owing to their slenderness they are variously crushed and broken. In the abdominal region (Pl. I, Fig. 6) the laminae of each arch ($na.$) are wide at the base, where those of successive segments are in close contact; but they rapidly become slender in their upper half, where they may have been surmounted by a separate neural spine. The right and left laminae are often displaced, so that both are partly exposed in side-view; and the numerous fractures and dislocations render it difficult to decide whether or not the upper part of the arch is really a distinct element. In the caudal region

(Pl. I, Fig. 1), where the neural arches become much shorter, there seems to be no basal expansion, so that the successive segments of the series are separated by conspicuous gaps. The hæmal arches in the abdominal region are imperfectly shown in the type specimen, but better in the fragment No. *f* (Pl. I, Fig. 6, *ha.*) Each arch consists of a pair of expanded pieces of calcified cartilage, which appear to be nearly square and slightly saddle-shaped when viewed from the attached face, but triangular when seen from the side. To the apex of each cartilage is fixed a short slender rib (*r*). The continuation of the hæmal series in the caudal region is well shown in the type specimen, the arches being crushed and displayed in various aspects. At first they are much smaller than the opposed neurals, but soon they become symmetrical with the latter. All the anterior caudal hæmal arches have an expanded triangular base, which rapidly tapers into the slender hæmal spine, and there is no separation into distinct elements. The posterior arches may have been as little expanded at the base as the opposed neurals. There are no clear indications of intercalary cartilages either dorsally or ventrally.

Appendicular Skeleton.—The pectoral girdle is shaped as usual in *Pleuracanthus*, and above the remains of the scapula in the type specimen (Pl. I, Fig. 1, *sc.*) the small elongate-triangular suprascapula (*ssc.*) is distinct. The pectoral fin (*pct.*) in the same specimen is imperfect and obscured by pyritised remains of the fish; but parts of it are shown more clearly in two other fossils (Pl. I, Figs. 7, 8). At least the three large proximal segments of the axis of this fin are longer than broad. The basal segment itself is only imperfectly seen in the type, but four or five preaxial rays, which must have been supported by it, are shown in Fig. 8 (*pr.*). From the distal end of what appears to be the third segment onwards the preaxial rays are best seen in Fig. 7. Twelve of these are indicated, all with the proximal segment of the same length, namely, between four and five times as long as broad; and the upper four exhibit the second segment nearly twice as long as this. There is then a third segment, which is partly broken away in the fossil. The preaxial border of the fin is strengthened by delicate dermal filaments (actinotrichia), which are conspicuous upon and between the distal ends of the cartilaginous rays in Fig. 7. The fossils are not sufficiently well preserved to exhibit any of the postaxial rays. Remains of both pelvic fins are shown in the type specimen (Pl. I, Fig. 1, *plv*), which is a male; and the fin of the left side is moderately well displayed. The

triangular basipterygia (*bpt.*) are longer than wide, and meet in the middle line at their attenuated apices. In their fossilised state they are pierced near their distal end by a few oval foramina, which may originally have been either pits or perforations. Each basipterygium bears at least six, perhaps eight, slender cartilage-rods, besides the basal piece of the long series of nearly square cartilages which form the clasper. The remains of the right pelvic fin exhibit at least twelve cartilages in this series, while the left fin shows a slight adjoining expansion, tapering distally, which seems to have been strengthened only by dermal filaments. The dorsal fin arises immediately behind the shoulder girdle and clearly extends continuously along the whole length of the back. It is supported as usual by long baseoste and comparatively short axonoste, each support bearing a tapering cartilaginous ray in the fin-membrane.

Subclass—**Dipnoi.**

Order—**SIRENOIDEI.**

Family—**CTENODONTIDÆ.**

Genus—**SAGENODUS**, *Owen*, 1867.

(*Trans. Odontol. Soc.*, v, p. 365.)

Gen. Char.—Body depressed, and covered with large thin scales, which are almost quadrate in shape but with the angles well rounded; both scales and external bones destitute of a ganoine-layer. A large median occipital plate posteriorly, with a smaller median plate immediately adjoining the front margin of this element. Dental plates, above and below, triangular, irregularly ovate or elliptical in form, with few strong, outwardly directed ridges, which are more or less tuberculated or crenulated; vomerine teeth resembling a single ridge of a dental plate. Dorsal and anal fins continuous with the caudal.

Obs.—*Sagenodus* occurs in the Carboniferous and Lower Permian both of Europe and North America. Fragments are not easily distinguished from the closely allied Carboniferous genus *Ctenodus*; but the exact determination of the Australian specimen now described is rendered possible by the preservation of the greater part of the palatine dental plates. At

least, if the fossil be not referable to *Sagenodus*, it belongs to *Ceratodus*; and, judging from the geological age of the specimen, the latter alternative is most improbable. It may be added that the roof of a skull of *Ctenodus* has already been discovered in the Carboniferous of Victoria, Australia.¹

SAGENODUS LATICEPS, *sp. nov.*

Plate II, Figs. 1, 2.

Obs.—Apart from a few scales, the type specimen (Pl. II, Figs. 1, 1a) is the only example of this species in the collection.

Sp. Char.—A stout species probably attaining a length of about a metre. Each palatine dental plate consisting of four very divergent ridges; and this pair of plates meeting in the middle line at an unusually wide angle.

General Form.—The type specimen is distorted in front where the head is turned round to the right side; and the greater portion of the caudal region is missing. Beneath and behind the head there are also scales of a Palæoniseid and pieces of Elasmobranch cartilage mingled with the fossil. It is thus impossible to determine the exact proportions of the fish. As suggested by remains of the palate, however, the head must have been comparatively short and broad; while the body seems to have been shorter and deeper than that of the European species in which the shape of the fish is known.

Head and Dentition.—Unfortunately the top of the head is not exposed, and the only distinct fragment of the skull is part of the palate seen from the oral aspect (Pl. II, Fig. 1a). The parasphenoid (*pas.*) exhibits the usual great expansion in front, but its exact boundaries are uncertain, and its sutural connection with the palatines is obscured. The palatine dental plates (*pl.*) are shown in horizontal section, and proved to be in direct contact in the median line. They meet at a much wider angle than is usual in the Dipnoans, and each dental plate consists of four well-separated, acute ridges, which are too incompletely preserved to show whether or not they were denticulated.

Vertebral Axis.—The elements of the axial skeleton of the trunk, and the fin-supports were evidently only superficially ossified or calcified, so that where broken in the fossil, they exhibit a central core of matrix or calcite. There are no traces of vertebræ, so the notochord was doubtless persistent.

Ctenodus breviceps, A. S. Woodward, Mem. National Mus. Melbourne, No. 1 (1906), p. 15, fig. 3.

Portions of some of the ribs (*r.*) are preserved in the abdominal region, showing that they were long, slender, and round in transverse section. Remains of some of the hour-glass-shaped neural spines (*na.*) are also seen in the same region.* These are very long and slender, and about equal in length to the complete neural arches in the anterior part of the caudal region, where they are similarly slender and constricted.

Appendicular Skeleton.—Of the fins, only part of the dorsal (*d.*) is preserved. It appears to arise at about the middle of the abdominal region, and is borne by the ordinary two series of hour-glass-shaped supports. The axonosts (*a.*), which slightly increase in length backwards, are not quite twice as long as the baseosts (*b.*), which are enveloped in the numerous dermal rays or actinotrichia. These dermal rays lengthen rapidly backwards, and each is a stout rod at its base but becomes subdivided and apparently crossed by sparse articulations at the distal end.

Squamation.—A few fragments of the large scales, showing their characteristic reticulating sutures, are preserved in the abdominal region of the type specimen. There are also some isolated scales, which are nearly complete though crushed, and one of them is shown in Pl. II, Fig. 2. These scales are very thin and more or less broken up during fossilisation into the small areas which are marked out by the reticulating sutures. They also exhibit the usual radiating, fine structural lines, besides indications of the concentric lines of growth. In shape they closely resemble the scales of *Ceratodus*, being deeply overlapping, with the anterior covered border almost truncate, the posterior free edge more sharply curved.

Subclass—**Teleostomi.**

Order—**ACTINOPTERYGII.**

Family—**PALÆONISCIDÆ.**

Genus—**PALÆONISCUS**, *Blainville*, 1818.

(Nouv. Dict. Hist. Nat., xxvii, p. 320.)

Gen. Char.—Trunk elongated. Mandibular suspensorium very oblique; mandible slender; teeth small, conical, and of different sizes. Fins relatively small, with minute fulcra, and the rays distally bifurcating, more

or less coated with ganoine; pectoral rays all articulated; the dorsal opposed to the space between the pelvic and anal fins; caudal fin forked. Scales partially sculptured with irregular transverse furrows and dots, and the hinder free margin usually serrated.

Obs.—This genus, as re-defined by Traquair (Quart. Journ. Geol. S. e., vol. xxxiii, 1877, p. 557), has hitherto been known with certainty only from the Upper Permian of Europe. The new Australian species now described, however, seems to be a typical form.

PALÆONISCUS CRASSUS, *sp. nov.*

Plate II, Figs. 3, 4.

Obs.—There are two examples of this species worthy of description, and a fragmentary isolated head may probably be ascribed to it:—

- (a) The type specimen, incomplete at each end (Pl. II, Fig. 3).
- (b) Portion of dorsal region of trunk (Pl. II, Fig. 4).
- (c) Internal cast of the greater part of the head, doubtfully of this fish.

Sp. Char.—A stout species, attaining a length of about 0·5 m. Depth of caudal pedicle contained two and a half times in the maximum depth of the abdominal region, which equals about one-third of the length from the pectoral arch to the base of the caudal fin. Pelvic fins arising slightly nearer to the anal than to the pectoral pair; dorsal fin arising opposite the hinder end of the pelvic pair, deeper than long, and its maximum elevation exceeding half the depth of the trunk at its insertion. Principal flank-scales deeper than long and ornamented with fine, oblique, transverse grooves and ridges; ventral scales deeper in proportion to their length than usual in *Palæoniscus*.

General Form.—The type specimen is sufficiently well preserved to exhibit the general proportions noted in the specific diagnosis, and shows that the back was only very slightly arched in advance of the dorsal fin. The relative size of the head and caudal fin is unknown.

Head and Dentition.—The hinder half of the head is seen in the type specimen partly from below, partly from the left side; but the bones are so much broken and traversed by a network of fissures that neither ornament nor outlines are distinct. The rather slender hinder half of the mandible (Pl. II, Fig. 3, *md.*) and the hinder expansion of the maxilla (*mx.*)

can be distinguished. The fragmentary detached head (No. *c*), which cannot be ascribed to *P. crassus* with certainty, exhibits a coarse but close tubercular ornament both on the mandible and on the branchiostegal rays, which are eighteen in number. The same fossil bears traces of clustered small and slender conical teeth, with a row of somewhat larger teeth at wide intervals.

Vertebral Axis.—As shown in Pl. II, Fig. 4, the neural spines (*n.s.*) in the region anterior to the dorsal fin are very long and slender. They exhibit a central cavity in the fossil, and must thus have been incompletely calcified. Obscure traces of them may also be seen just behind the head in the type specimen.

Appendicular Skeleton.—As usual in *Palæoniscus*, all the fins are relatively small. The rather stout fin-rays are closely articulated to the base, and they are ornamented with longitudinal flutings, of which there are traces in all the fins of the type specimen. Small and delicate fulcra occur on the anterior border of the dorsal fin in both specimens, and they would doubtless be seen on the other fins if these were sufficiently well preserved. There are indications of the clavicle (*cl.*) and the forwardly extended infraclavicle (*icl.*) in the type specimen, and the pectoral fin (*pct.*) is imperfect. A pelvic fin (*plv.*) is nearly complete, and is distinctly deeper than long, with about twenty rays articulated quite to the base. Its foremost five or six rays gradually increase in length to the longest. The dorsal fin (*d.*), which arises immediately opposite the hinder end of the pelvic pair, is also somewhat deeper than long, with about thirty rays, of which the foremost few gradually increase in length to the longest. The anal fin (*a.*) is incomplete in the fossil, but must have been smaller than the dorsal fin, which is well in advance. Of the caudal fin (*c.*) only fragments remain.

Squamation.—There are about forty-five transverse series of scales between the occiput and the dorsal fin; and those of the caudal region are probably not more numerous. The principal scales of the flank are distinctly deeper than long, while those towards the ventral margin are seen to be somewhat longer than deep. The squamation, however, is much obscured by the reticulating fissures already mentioned as traversing the head-bones. Traces of the peg-and-socket articulation are observable in some parts, and fine oblique sculpturing can be seen on the scales immediately above and behind the head; but it is uncertain whether the hinder border of the scales was serrated. There is obviously no series of very large ridge-scales, but

portions of two of the slightly enlarged ridge-scales in front of the dorsal fin are shown in Pl. II, Fig. 4. They are oval in shape, and ornamented with fine concentric ridges.

Genus—ELONICHTHYS, *Giebel*, 1848.

(Fauna der Vorwelt, Fische, p. 249.)

Gen. Char.—Trunk more or less deeply fusiform. Mandibular suspensorium very oblique; jaws stout and dentition powerful, a close series of small conical teeth, with a spaced series of large conical teeth within. Fins large, with fulcrum, the rays branching distally, covered with ganoine, and the more robust sculptured; pectoral rays all articulated; pelvic fins with short base-line; dorsal opposed to space between pelvic and anal fins; upper caudal lobe much produced, the fin deeply forked and inequilobate. Scales very slightly overlapping, covered with ganoine, more or less sculptured; ridge-scales immediately in front of median fins much enlarged.

Obs.—This genus is represented by several species, ranging from the Lower Carboniferous to the Lower Permian, both in Europe and North America. Two species also occur in a sandstone, apparently of Carboniferous age, at Mansfield, Victoria, Australia.*

ELONICHTHYS ARMATUS, *sp. nov.*

Plate III, Fig. 1.

Obs.—The type specimen (Pl. III, Fig. 1) is the only example of this species worthy of description.

Sp. Char.—A comparatively elongated species, attaining a length of about 0.65 m. Maximum depth of trunk contained somewhat more than three times in the length from the pectoral arch to the base of the caudal fin. Fin-rays very stout, and some at least ornamented with few oblique ridges; pelvic fins arising midway between the pectoral and anal fins. Scales relatively large and thick, those of the middle of the flank in the abdominal region considerably deeper than broad; none posteriorly serrated. Scale-ornament consisting of a few large oblique ridges, which extend backwards

* A. S. Woodward, Mem. National Mus. Melbourne, No. 1, 1906.

and downwards from the anterior and upper borders, sometimes disappearing, sometimes fusing as they converge and approach the postero-inferior margin, which is nearly or quite smooth.

General Form.—Like many examples of the genus *Elonichthys*, which comprises stout-bodied fishes with large fins, the type specimen of *E. armatus* is much distorted. As proved by the position of a remnant of the lateral line, it also lacks part of the dorsal border; while the hinder portion of the caudal region is broken away. It seems probable, however, that the length of the head with opercular apparatus about equalled the maximum depth of the trunk, which must have been less than one-third of the length from the pectoral arch to the base of the caudal fin.

Head.—The fragmentary remains of the rather stout head-bones are exposed chiefly from beneath, and there are the bases of longitudinal rows of small teeth in an indeterminable position. Part of the series of branchiostegal rays (*br.*) of the right side is also seen.

Appendicular Skeleton.—One of the large pectoral fins (*pect.*), broken away only at the base, is spread upon the rock and exhibits not less than thirty rays, which are closely articulated throughout the length preserved, and are finely divided distally. Part of the anterior border of the fin still retains some of the small fulera, with which it was originally fringed. One of the pelvic fins (*plv.*) is more satisfactorily shown, and is scarcely, if at all, inferior in size to the pectoral fin. The length of its base-line is considerably less than that of its longest fin-ray; and its anterior border is fringed with well-preserved small, slender fulera. All its rays are closely articulated to the base and finely divided distally, while some obscure impressions of their outer face prove that they bore a coarse ornament of oblique ridges. A few of the anterior rays gradually increase in length, successively terminating at the gently curved anterior border. The anal fin (*an.*) is larger than the pelvic fins, but otherwise is closely similar to the latter.

Squamation.—The scales are much fractured, and some of them are displaced in the fossil, while most of them are shown only in impressions of the outer face. In the abdominal region the principal scales of the flank (Fig. 1*a*) are somewhat deeper than broad, and one series of these slightly deepened scales is traversed by the large canal of the lateral line (Fig. 1, *l*). The scales at the ventral border are broader than deep, but not excessively so. The overlapped margin of each scale is moderately wide, and the hinder edge

does not appear to have been serrated. The external ornament is remarkably uniform over all parts of the body, consisting of a few large, oblique ridges, which are described in the specific diagnosis.

Affinities.—*Elonichthys armatus* is distinguished from the two known Australian species and from many other species by the absence of serrations on the scales. The peculiarly coarse scale-ornament also separates it from the remaining described forms. It seems to approach most nearly some of the Upper Carboniferous species.

ELONICHTHYS SEMILINEATUS, *sp. nov.*

Plate IV, Fig. 1.

Obs.—This species is known only by a few fragmentary specimens, of which three may be enumerated:—

- (a) Middle portion of small trunk, the type (Pl. IV, Figs. 1, 1a).
- (b) Distorted portion of larger trunk, with remains of the dorsal, anal, and pelvic fins.
- (c) Greater portion of equally large trunk, somewhat distorted, showing only the dorsal fin.

Sp. Char.—Probably attaining a length of about 0·35 m. Fin-rays very stout, and, some at least, ornamented with fine longitudinal ridges; dorsal fin arising opposite the hinder end of the pelvic fins. Scales only moderately thick, and those of the middle of the flank in the abdominal region slightly deeper than broad; posterior serrations very slight or absent. Scale ornament consisting in the lower part of fine horizontal lines coinciding with the concentric lines of growth; in the antero-superior area of a few broad ridges, separated by narrow grooves, directed obliquely downwards and backwards, and passing behind into finer, more numerous, oblique ridges.

General Form.—Not clearly determinable, but probably much the same as that of *E. armatus*.

Head.—Too imperfectly known for description.

Appendicular Skeleton.—The pelvic, dorsal, and anal fins are shown to have been fringed with small, slender fulera, and the articulations of the stout fin-rays are moderately distant, so that the pieces between them are slightly longer than broad. There are also occasional traces of fine

longitudinal ridges ornamenting the rays. In the type specimen and No. *b*, the pelvic fins are almost completely in advance of the dorsal fin; and the latter specimen seems to show that they are deeper than long. Both the dorsal and anal fins are incomplete even in No. *b*, but the former seems to have been slightly larger than the latter, and it is proved by the type specimen to have been supported by the usual double series of cartilages (Pl. IV, Fig. 1, *d.b.*, *d.a.*). The stout, hour-glass-shaped basecosts (*d.b.*) are half as long as the corresponding axonosts (*d.a.*), which are distorted in such a manner as to suggest that they were only slightly ossified.

Squamation.—The scales are only well seen in part of the type specimen. They are slightly deeper than broad on the middle of the flank in the abdominal region, while the dorsal scales are approximately equilateral, and those near the ventral border are not much broader than deep. The upper and lower borders are straight, and the external face is completely covered with ornament (Pl. IV, Fig. 1*a*). The chief portion of the ornament consists of oblique ridges, which begin few, broad, and flattened in the antero-superior area, and then subdivide into numerous finer ridges, which terminate at the hinder border of the scale, perhaps in a finely serrated edge. Near the lower border of the scale the ornament consists of fine horizontal lines. Two enlarged ovate ridge-scales, closely ornamented with longitudinal ridges, occur in front of the dorsal fin in the type specimen; and there is an obscure trace of a similar scale in front of the anal fin in No. *b*.

Affinities.—The relative coarseness of the ornament on the antero-superior portion of the scales distinguishes *Elonichthys semilineatus* from all the known species of the same genus.

Genus—MYRIOLEPIS, *Egerton*, 1864.

(Quart. Journ. Geol. Soc., xx, p. 3.)

Gen. Char.—Trunk fusiform, but robust. Mandibular suspensorium very oblique; dentition comprising a spaced series of large conical teeth. Fins rather large, with fulera, the rays branching distally; dorsal fin opposed to space between pelvic and anal fins; caudal fin deeply cleft, equilobate. Scales very small, obliquely striated, enlarged upon the sides of the upper caudal lobe; ridge-scales of upper caudal lobe prominent.

Obs.—Since the last description of *Myriolepis* from the Hawkesbury Formation of New South Wales,¹ a small species of this genus has been discovered in the Coal Measures of Ireland.² Another new species occurs in Mr. Dunstan's collection from St. Peter's.

MYRIOLEPIS PECTINATA, *sp. nov.*

Plate III, Figs. 2, 3.

Obs.—All the remains of this large species are very fragmentary, and it is only necessary to refer to three specimens, namely:—

- (a) The type specimen (Pl. III, Fig. 2), which exhibits the greater part of the trunk, with traces of the head and fins.
- (b) A fragment of abdominal region, displaying the scale-ornament (Pl. III, Fig. 3).
- (c) A fragment of caudal region, showing hinder part of dorsal fin.

Sp. Char.—A stout species attaining a length of about 0·7 m. Maximum depth of trunk contained about three times in the length from the pectoral arch to the base of the caudal fin; the same measurement equalling the distance from the origin of the pectoral fins to a point just behind the origin of the pelvic fins. Pelvic fins situated as in the type species, but the dorsal fin apparently more remote, being partly opposed to the anal fin. Principal flank-scales in abdominal region much deepened; dorsal and ventral scales scarcely broader than deep; all scales ornamented with a few coarse horizontal ridges, which sometimes bifurcate in front.

General Form.—The type specimen (Pl. III, Fig. 2) appears to be only slightly distorted, and probably justifies the statement of proportions given above. The length of the head is not indicated. The body must have been much laterally compressed.

Head.—The remains of the head show that some of the external bones were ornamented with closely arranged, large tubercles, others with rounded ridges. The great obliquity of the mandibular suspensorium is evident; and some of the smaller clustered conical teeth are seen in impression

¹ A. S. Woodward, "The Fossil Fishes of the Hawkesbury Beds at Gosford," Mem. Geol. Surv. N. S. Wales, No. 4 (1890), pp. 7-11, Pl. II, Figs. 3, 4; Pl. III, Figs. 1-3.

² R. H. Traquair, "On a new Palaeoniscid Fish, *Myriolepis hibernicus*, sp. nov., from the Coal Measures, Co. Kilkenny, Ireland," Geol. Mag., [3], x (1893), p. 54, Pl. III. Also H. Bolton, "Note on *Myriolepis hibernica*, Traq.," Trans. Manchester Geol. Soc., xxii (1894), pp. 1-4, Pls. I, II.

both on the front part of the maxilla (*mx.*) and on the hinder part of the dentary (*md.*). The opercular apparatus (*op.*) is narrow, and coarsely ornamented with tubercles. Owing to fractures, the line of suture between the operculum and suboperculum (*sop.*) is uncertain; but it seems to be low down, as if the operculum were very deep and narrow, not relatively small. The usual broad branchiostegal rays (*br.*) are seen below.

Vertebral Axis.—The neural and hæmal arches of the vertebral axis are sufficiently well calcified to be preserved, and many of them are exposed. In the abdominal region, the long and slender neural spines (*n.s.*) are separate from their short supporting arches; while the hæmal elements are merely paired bosses of calcified cartilage, which are slightly displaced in the fossil so as to be shown one series above the other.

Appendicular Skeleton.—Traces of the pectoral arch are preserved, the supraclavicle being deep and narrow, and meeting the tapering upper end of the clavicle, where there seems to be a small postclavicular plate. The large infraclavicles (*i.cl.*) are conspicuous. Some obscure remnants of closely articulated rays appear to represent the pectoral fin (*pct.*). All the rays of the fins are stout and rather closely articulated to the base, while their outer face (when seen as preserved in the dorsal fin) is ornamented with fine longitudinal flutings. Remains of the anterior edge of both pelvic fins (*plv.*) occur, with indications of a fringe of small fulcra. Only the middle portions of the dorsal (*d.*) and anal (*an.*) are seen in the type specimen, the former being in an unusually remote position. The low, fringing, posterior extension of the dorsal fin is preserved in No. *c.*

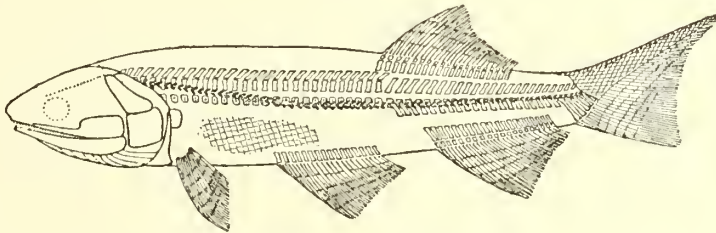
Squamation.—The scales are shown in the type specimen in all conditions, sometimes from the outer or inner face, often fractured, sometimes as mere impressions. Their external face is better seen in the fragment No. *b.* They are relatively small and thick, in regular order over the whole of the trunk, and ornamented with coarse ridges, which often exhibit a fine secondary longitudinal striation. The ornamental ridges apparently do not produce serrations at the hinder border of the scales. As shown by an impression of the outer face (Pl. III, Fig. 3), the principal flank-scales in the anterior part of the abdominal region are twice as deep as broad, and their overlapped border is narrow. Their ornamental ridges, which often bifurcate in front, are only slightly oblique. As shown in the middle of the abdominal region in the type specimen, the scales are united by a large

median peg-and-socket articulation; but the usual thick vertical ridge on their inner face is not very conspicuous. Towards the dorsal and ventral borders and on the caudal region the scales are nearly equilateral, and the main direction of the ornamental ridges is parallel with the diagonal. No ridge-scales are preserved.

Affinities.—This is the largest known species, and is evidently closely related to the typical *Myriolepis Clarkei*. It differs from the latter and the two other known species by the slightly more remote position of its dorsal fin; and it is also distinguished from *M. hibernica* by its coarser scale-ornament.

Genus—**ELPISOPHOLIS**, *novum*.

Gen. Char.—Trunk fusiform, elongated. Head-bones thin; mandibular suspensorium very oblique; dentition powerful. Fin-rays stout, with few distant articulations, and finely divided distally; fulera absent. Pelvic fins with much extended base-line; dorsal and anal fins also considerably extended, the former arising somewhat in advance of the latter; caudal fin scarcely if at all forked. Greater part of the trunk naked, but the lower part of the abdominal region covered with thin rhombic scales, which exhibit concentric lines of growth; a row of overlapping <-shaped scutes along the course of the lateral line; small diamond-shaped scales on the slender upper caudal lobe.



Restoration of *Elpisopholis Dunstani*.

Obs.—Among known genera, *Elpisopholis* appears to be most nearly related to *Phanerosteon*,¹ from the Lower Carboniferous of Scotland, and to *Sceletophorus*,² from the Lower Permian of Bohemia. It differs from all Palæoniscidæ hitherto discovered in the presence of the thickened scutes along the course of the lateral line.

¹ R. H. Traquair, Trans. Roy. Soc. Edinb., xxx (1881), pp. 39-43, Pl. III, Figs. 6-8.

² A. Fritsch, "Fauna der Gaskohle Permform. Böhmen," iii (1895), p. 88.

ELPISOPHOLIS DUNSTANI, *sp. nov.*

Plate IV, Figs. 2-5.

Obs.—This remarkable new species is represented in the collection by numerous fragments of fishes grouped together as if they had died in a shoal. The following are the more important specimens:—

- (a) Imperfect fish, the type specimen (Pl. IV, Fig. 2).
- (b) Remains of two heads, one shown in side-view, the other from beneath (Pl. IV, Fig. 3).
- (c) Head and anterior portion of trunk, with remains of other individuals, in counterpart.
- (d) Head in side-view.
- (e) Fragment of tail, probably of this species (Pl. IV, Fig. 5).

Sp. Char.—The type species, attaining a length of about 0.15 m. Length of head with opercular apparatus considerably exceeding the maximum depth of the trunk, which is contained about six times in the total length of the fish. External bones not ornamented. Pelvic fins arising slightly nearer to the pectorals than to the anal fin; dorsal and anal fins with about thirty rays, partly opposed. Scales apparently not ornamented.

General Form.—The type specimen (Pl. IV, Fig. 2) displays the general proportions of the trunk, with remains of its very slender upper caudal lobe. The same fossil also shows the obliquity of the mandibular suspensorium and enough of the head to estimate its length on the basis of other specimens. The result of measurements is given above, and a restored sketch of the fish is attempted in the accompanying text-figure. In several cases the head is exhibited from above or below, and thus appears to have been not much laterally compressed.

Head.—The bones of the head and opercular apparatus are remarkably thin, and in the fossils they exhibit no markings except the concentric lines of growth. The oral border of the maxilla (Pl. IV, Fig. 2, *mx.*) is slightly arched or sinuous, and its hinder expansion is about twice as long as deep. The mandible, which is fragmentary in the original of Pl. IV, Fig. 3, is slender. The teeth of both jaws, seen chiefly in section and impression in Nos. *b*, *d*, are stout hollow cones, rather large, and nearly uniform in size, except where they diminish at the hinder end of the series. The opercular apparatus is narrow and tapers upwards. The outline of the operculum

(Pl. IV, Fig. 4, *op.*) is nearly an isosceles triangle, of which the base-line measures half the height. The suboperculum (restored in Pl. IV, Fig. 4, *sop.*, from No. *d*) is as deep as the operculum and much wider, almost trapezoidal in shape, with the upper edge little more than half as long as the lower edge. The branchiostegal rays (Pl. IV, Fig. 3, *br.*) are rather broad plates, arranged in at least twelve pairs, of which the foremost is the broadest, evidently with the usual median plate in front.

Vertebral Axis.—Owing to the partial absence of scales, and to the thinness of those that remain, traces of the vertebral axis are observable in all specimens. A vacant space indicates that the notochord must have been persistent, while the vertebral arches have the appearance of being only superficially calcified. These arches are stout, and the type specimen exhibits about twenty-four in regular close series between the occiput and the origin of the dorsal fin, which is approximately the beginning of the caudal region. Each neural arch in the abdominal region consists of a deep pair of laminæ, surmounted by a stout and scarcely shorter, separate neural spine, which is truncated at the upper end. Behind the origin of the dorsal fin the neural spine disappears, and the arch consists only of the still separate pair of laminæ. The hæmal arches in the abdominal region are merely paired knobs of cartilage, which are well seen in the type specimen (*ha.*), where the middle part of the series is accidentally displaced downwards. The hæmal arches in the caudal region are as short as the opposed neurals, to which they appear to be similar. One fragment of caudal fin (Pl. IV, Fig. 5), which probably belongs to this genus and species, exhibits a row of endoskeletal cartilages supporting the dorsal fulcra (*f.*), only somewhat smaller than the equally well-preserved hæmal arches (*ha.*) supporting the rays of the lower lobe (*c.*).

Appendicular Skeleton.—The pectoral arch is tolerably well shown both in the type and in other specimens, and does not appear to be ornamented. The supraclavicle (Pl. IV, Fig. 2, *scl.*) is nearly as long as the clavicle, and meets the latter at a considerable angle. It is widest above and tapers somewhat below, while its outer face sometimes exhibits the oblique channel for the usual traverse of the lateral line. The clavicle (*cl.*) is slender, deeply overlapping the ascending process of the infraclavicle, which appears in the type specimen as a small triangular plate just below the insertion of the pectoral fin. At the upper end of the clavicle there is a large postclavicular plate (*pcl.*), which is considerably deeper than broad,

and exhibits only concentric lines of growth. The infraclavicle (Pl. IV, Fig. 3, *icl.*) is relatively large, tapering forwards to a blunt point. The pectoral fin (Pl. IV, Fig. 2, *pet.*) is only known by fragments, but its rays seem to be similar to those of the other fins. The pelvic fin (*plv.*) is better shown and remarkable for the length of its base-line; though its maximum depth probably almost equalled this length. It comprises at least twenty-five rays, which are only articulated at distant intervals, but very finely divided distally; and in the anterior part of the fin in the type specimen there are traces of the row of stout supporting basecosts. The dorsal fin (*d.*) comprises about thirty rays, of which the few foremost gradually increase in length to the longest; and the extreme height of the fin nearly equals the depth of the trunk at its insertion. The rays are distantly articulated, and supported by a less numerous series of short and stout basecosts, which are opposed to an equal number of longer axonosts, all very imperfectly calcified. The anal fin (*an.*) arises opposite the middle of the dorsal and is apparently similar to the latter. Some of its imperfectly calcified basecosts and axonosts are well shown in the type specimen, thirteen of these supports corresponding with about twenty-one rays. The upper caudal lobe is remarkably slender, and the caudal fin (*c.*) seems to have been only very slightly forked. Its stout distantly-articulated rays are finely divided distally.

Squamation.—A patch of thin rhombic scales is always seen covering the lower part of the abdominal region. Some of the scales are slightly deeper than broad, while those near the ventral border are about equilateral; and all exhibit marks of their concentric lines of growth. There are also thicker and smaller rhombic scales on the upper caudal lobe. No ordinary scales, however, are preserved on any other part of the fish; and the only remains of dermal armature are a row of thick scutes along the lateral line of each side (Pl. IV, Fig. 2, *sc.*). These scutes are <-shaped or arrow-head-shaped, and arranged in close series, partly overlapping, with the apex directed forwards.

Family—**PLATYSOMIDÆ.**

Genus—**PLATYSOMUS**, *Agassiz*, 1835.

(Poiss. Foss., ii, Pt. i, pp. 6, 161.)

Cbs.—This genus ranges from the Lower Carboniferous to the Upper Permian in Europe, and has also been discovered in the Coal Measures of North America. It is only represented in the collection from St. Peter's by

a few characteristic scales, which are not sufficient for specific determination. These scales are completely covered with fine, regular, vertical striæ, which are as delicate as those on the most delicately ornamented scales of the same genus from the English Coal Measures (*Platysomus tenuistriatus*). So far as shown, the striæ are not subdivided into tubercles.

Family—SEMIONOTIDÆ.

Genus—ACENTROPHORUS, *Traquair*, 1877.

(Quart. Journ. Geol. Soc., xxxiii, p. 565.)

Obs.—This typically Upper Permian genus has not hitherto been discovered with certainty beyond the limits of Europe. It occurs in the Magnesian Limestone and Marl Slate of Durham, and in the contemporaneous Kupferschiefer of Eisleben, Saxony (Halle Museum); but records of other species elsewhere are doubtful and based on imperfect materials. One specimen in Mr. Dunstan's collection, however, exhibits much resemblance to *Acentrophorus*, and may probably be referred to it. This fossil (Pl. IV, Fig. 6) unfortunately lacks the head, and is otherwise too imperfect for specific determination, but it is worthy of a brief description. As seen in side-view, the back is gently arched, and the maximum depth of the trunk is contained nearly three times in the length from the pectoral arch to the base of the caudal fin. Traces of the vertebral axis are visible through the thin squamation, and there is a vacant space indicating a persistent notochord. Each of the hæmal arches in the caudal region consists of a single piece, and the hæmal spines at the base of the caudal fin are especially stout. The pelvic fins seem to have been small, and are inserted twice as far from the pectoral fins as from the anal fin. The few rays preserved are addressed to the trunk, and lack the fulera. The remains of the dorsal fin are opposed to the space between the pelvic and anal fins, and extend slightly further backwards. There is a cluster of large fulera at the origin of this fin, but the bases of its thick rays are seen to be well spaced. The anal fin rays are equally stout and somewhat spaced, and their eleven rod-shaped supports can be easily counted. The greater part of the caudal fin is destroyed, but appearances suggest that the upper lobe of the caudal pedicle is as much shortened as in *Acentrophorus*. Although the scales are only represented in the fossil by a ferruginous stain,

they are shown to be rhombic in shape and approximately equilateral, covering the whole trunk and not becoming narrow near the ventral border. The lateral line is conspicuous.

B.—From Soft Grey Shale or Mudstone.

Family—PALÆONISCIDÆ.

Genus—PALÆONISCUS, *Blainville*, 1818.

(See page 8.)

PALÆONISCUS ANTIPODEUS, *Egerton*.

Plate IV, Fig. 7.

Palæoniscus antipodeus, Egerton, Quart. Journ. Geol. Soc., 1864, xx, p. 4, Pl. I, Fig. 4, and wood.

Obs.—Two small specimens are referable to this species, but are not sufficiently well preserved to exhibit definite generic characters. The reference of the species to *Palæoniscus* thus still remains doubtful.

Sp. Char.—A species attaining a length of about 0·2 m. Maximum depth of trunk contained three times in the length from the pectoral arch to the base of the caudal fin. Pelvic fins arising slightly nearer to the anal than to the pectoral fins; dorsal fin opposed to the space between the pelvic and anal fins, but not extending further backwards. Principal flank-scales considerably deeper than broad; from twenty-five to thirty transverse series of scales in advance of the dorsal fin.

General Form.—The nearly complete trunk, perhaps lacking the extremity of the upper caudal lobe, is shown in direct side-view in the small fossil (Pl. IV, Fig. 7). The distorted remains of the head in the second specimen prove that its length must at least have equalled the maximum depth of the trunk.

Head.—The large, forwardly placed orbit is seen in the second specimen, and a fragment of bone at the back of the head is ornamented with parallel ridges.

Appendicular Skeleton.—All the fin-rays are slender and articulated only at distant intervals. As preserved, they do not exhibit any traces of ornamentation. A few anterior rays in each median fin gradually increase in

length to the longest; and there are traces of minute fulcra on the distal half of the anterior border thus formed. All the fins are incomplete distally in both specimens, but their relative position is shown to be as noted in the specific diagnosis.

Squamation.—The scales form a regular and complete covering, but it is uncertain whether they are ornamented. The smaller specimen seems to exhibit traces of fine serrations on the hinder margin of some of the flank-scales. The scales of the dorsal and ventral regions and towards the hinder half of the tail are nearly equilateral, while the principal scales of the flank are at least twice as deep as broad. The lateral line is very conspicuous in the fossils, and the scales traversed by it are scarcely, if at all, deeper than those immediately above and below.

Affinities.—In many respects this fish is suggestive of the slender species of *Amblypterus* from the Lower Permian of Europe. The discovery of satisfactory specimens will therefore be awaited with interest. An imperfect fish referred by Feistmantel to *Palæoniscus antipodeus*, is distinguished from this species by the more remote position of its dorsal fin and the smaller size of its scales; but it doubtless belongs to the same genus as the two specimens now described. It may be provisionally named *Palæoniscus Feistmanteli*.

Family—SEMIONOTIDÆ.

Genus—SEMIONOTUS, *Agassiz*, 1832.

(Neues Jahrb. f. Min., 1832, p. 144.)

Obs.—Two species of this genus have already been recorded from the Hawkesbury Formation at Gosford. Another species, evidently new, occurs at St. Peter's.

SEMIONOTUS FORMOSUS, *sp. nov.*

Plate IV, Fig. 8.

Obs.—Besides fragments, there are two important specimens displaying most of the specific characters of this fish :—

- (a) The type specimen (Pl. IV, Fig. 8), lacking the pectoral fins and the greater part of the caudal fin.
- (b) A more imperfect fish, somewhat distorted, with remains of the paired fins.

Sp. Char..—An elongated species, attaining a length of about 0·2 m. Back not elevated, but depth of caudal pedicle contained probably nearly three times in the maximum depth of the abdominal region. Length of head with opercular apparatus slightly less than this maximum depth, and occupying one quarter of the total length of the fish to the base of the caudal fin; maxilla and mandible with coarse longitudinal ridge-ornament, which is more or less irregular and anastomosing. Pelvic fins arising slightly nearer to the anal than to the pectoral fins; dorsal fin, with about fifteen rays, arising just behind the middle point of the back, more than half as deep as the trunk at its point of origin; anal fin with not less than eleven rays, arising just behind the middle of the dorsal fin. Principal flank-scales not much deeper than broad; about twenty-five to thirty transverse series between the pectoral arch and the origin of the dorsal fin.

General Form..—The type specimen is probably only a little distorted in the region of the caudal pedicle, which seems to be somewhat shortened and deepened. The figure (Pl. IV, Fig. 8) therefore shows approximately the original shape of the fish, though the fins are defective.

Head..—The general proportions of the head are well displayed in side view in the type, while the coarse longitudinal ridge-ornament of the maxilla and mandible is seen in both specimens. The eye is relatively large, and there are evidently extensive cheek-plates. The maxilla is deepest behind, and its oral margin forms a slightly convex curve. The opercular apparatus is shown as an internal impression, which bears a groove where the deep suboperculum was overlapped by the operculum. There are traces of the usual branchiostegal rays and a median gular plate crushed beneath the mandible.

Appendicular Skeleton..—As shown by the second specimen, the rays of the pectoral fin are more delicate than those of the other fins. They are at least fourteen in number, while the foremost and stoutest ray is fringed by large, slender fulcra. The pelvic fin, which is adpressed to the trunk and incomplete distally in the type specimen, cannot have comprised more than five or six rays, but these are rather large and stout: its fringing fulcra resemble those of the pectoral fin. The dorsal fin seems to be nearly complete in the type specimen, and exhibits fourteen or fifteen well-spaced rays. Some of its basal fulcra are relatively large and marked with fine longitudinal

striations. The anal fin is fragmentary in the fossils, but must have been comparatively small. The apparently complete length of the lower lobe of the caudal fin is shown in Pl. IV, Fig. 8.

Squamation.—The scales exhibit little more than their shape. In the two principal specimens the only markings observable on the remains of scales are the concentric lines of growth; but in one fragmentary specimen, perhaps of the same species, there are impressions of a coarse crimping of the posterior margin. The principal flank-scales are slightly deeper than broad, while the dorsal and ventral scales are nearly as deep as broad. The dorsal ridge-scales are seen, but not very prominent. The lateral line impresses a deep, obliquely-directed groove on each scale traversed.

Affinities.—This species is distinguished from *Semicnotus tenuis* and *S. australis* by the less deepened shape of its principal flank-scales. The definition given above also separates it from other known species.

Genus—CLEITHROLEPIS, *Egerton*, 1864.

(Quart. Journ. Geol. Soc., xx, p. 3.)

CLEITHROLEPIS GRANULATUS, *Egerton*.

Obs.—Two imperfect examples of this species are included in a supplementary collection from the mudstone of St. Peter's, sent to me by Mr. J. E. Carne.

Family—PHOLIDOPHORIDÆ.

Genus—PHOLIDOPHORUS, *Agassiz*, 1832.

(Neues Jahrb. f. Min., 1832, p. 145.)

Obs.—A small and rather abnormal species of this genus has already been described from the Hawkesbury Beds at Gosford. A unique specimen in Mr. Dunstan's collection from St. Peter's seems to represent a more ordinary member of the genus.

PHOLIDOPHORUS AUSTRALIS *sp. nov.*

Plate IV, Fig. 9.

Obs.—This species is known only by the type specimen, which is shown of the natural size in Pl. IV, Fig. 9.

Sp. Char.—A small species attaining a length of at least 0.1 m. Length of head with opercular apparatus nearly equalling maximum depth of trunk, and occupying one-fifth of total length of fish. Pelvic fins, each with six or seven rays, arising much nearer to the anal than to the pectoral fins; dorsal fin with twelve rays, directly opposed to the space between the pelvic and anal fins; anal fin relatively small, with about ten rays. Scales moderately deepened on the flank, apparently smooth.

General Form.—The type specimen is displayed in direct side view, and probably shows the true shape and proportions of the fish. The trunk is regularly fusiform, and the caudal pedicle is remarkably slender.

Head.—The head appears to be complete in the fossil, though none of its details can be clearly seen. In both jaws there are impressions of a close series of slender conical teeth, which are unusually large.

Appendicular Skeleton.—There are remains of both pectoral fins, which must have been inserted close to the ventral border. The pelvic fins arise much nearer to the anal fin than to the pectorals: one clearly comprises six or seven rays, which are stout at the base though finely divided distally, but the foremost preserved is not fringed with fulcra. The dorsal fin, consisting of twelve rays, is directly opposed to the space between the pelvic and anal fins, and does not exhibit any distinct evidence of fulcra. The anal fin is only about half as large as the dorsal, with approximately ten crowded rays, which are finely divided distally. Small fulcra are observable at the origin of the anal fin, and are very conspicuous on both lobes of the symmetrically forked caudal fin.

Squamation.—The scales are badly preserved, and do not exhibit any traces of ornamentation. Those of the dorsal region and on the caudal pedicle are nearly equilateral, without any remains of enlarged ridge-scales. Those of the middle of the flank are slightly deepened.

Affinities.—Though evidently representing the typical section of the genus *Pholidophorus*, this species is too imperfectly known for the more exact determination of its relationships.

III.—CONCLUSION.

The fish fauna now described from the indurated shale of St. Peter's is of special interest, because all the genera comprised in it are new to the Hawkesbury Formation, except *Myriolepis*, and perhaps *Palæoniscus*. The aspect of this fauna is, indeed, distinctly older than that of the Hawkesbury-Wianamatta fish-faunas previously discovered. *Pleuracanthus*, *Sagenodus*, *Elonichthys*, and *Platysomus* are common in Europe in rocks even so old as the Lower Carboniferous; but they range upwards partly to the Lower, partly to the Upper Permian. *Palæoniscus* and *Acentrophorus* are essentially Upper Permian; while *Elpisopholis* is a genus which can scarcely be of earlier date than the Permian. The new St. Peter's fauna may, therefore, best be termed Permo-Carboniferous.

The discovery of the nearly complete skeleton of *Pleuracanthus* is fortunate, because it proves definitely that the Diplodont teeth of the Australian Hawkesbury Formation belong to the same type of shark as those of the European Carboniferous and Lower Permian strata. The known geographical range of the characteristically Permo-Carboniferous Ichthyotomi is therefore remarkably extended. The peculiarities of the dorsal spine, however, as well as the conformation of the anal fins, still remain unknown; and better specimens of the head and branchial apparatus are much to be desired.

The fragmentary skeleton of *Sagenodus* is of great interest when considered in connection with other recent discoveries of extinct Dipnoan fishes in Australia. There is now evidence of forerunners of the surviving *Ceratodus* in the Devonian of New South Wales,¹ the Carboniferous of Victoria,² the Permo-Carboniferous and Triassic of New South Wales,³ and the Jurassic of Victoria⁴. It is thus clear that Dipnoi have always lived in the Australian region, and there is no reason why *Ceratodus* itself may not have evolved there.

An undoubted *Palæoniscus* has never hitherto been found in any formation beyond the Upper Permian, Kupferschiefer, and Marl Slate of

¹ *Ganorhynchus Sussmilchi*, R. Etheridge, jun., Rec. Austr. Mus., vi (1906), p. 129, Pl. XXVIII.

² *Otenodus breviceps*, A. S. Woodward, Mem. National Mus. Melbourne, No. 1 (1906), p. 15, Fig. 3.

³ *Gosfordia truncata*, A. S. Woodward, Mem. Geol. Surv. N. S. Wales, No. 4 (1890), p. 5, Pl. I, Pl. II, Figs. 1, 2.

⁴ *Ceratodus avus*, A. S. Woodward, Ann. and Mag. Nat. Hist. [7] xviii (1906), p. 2, Pl. I Fig. 1.

western Europe, but the new *P. crassus* from St. Peter's seems to be rightly placed in this genus. It will be interesting to study the details of the cranial osteology of this fish when sufficiently satisfactory specimens of the head are met with.

The occurrence of typical species of the Palæoniscid fish *Elonichthys* in the Permo-Carboniferous of New South Wales was to be expected, because it had already been found in the Carboniferous of Victoria, and it is extremely characteristic of later Palæozoic rocks both in Europe and North America. The two species from St. Peter's, like most species hitherto named, are very imperfectly known, but their scale-ornament seems to be sufficiently peculiar to separate them from all species discovered elsewhere. The large fins, and probably also the rounded shape of the trunk, cause nearly all the examples of *Elonichthys* to be much distorted.

The new species of *Myriolepis*, which is the largest hitherto described, adds a few details to our knowledge of this genus, and seems to show that the small species from the Irish Coal Measures, which has been referred to it, is rightly placed here.

Elpisopholis is a remarkable discovery, but has been expected since the Hawkesbury specimens of *Belonorhynchus* first demonstrated the close relationship of the Belonorhynchidæ with the Palæoniscidæ.¹ The new genus is, indeed a Palæoniscid fish, but it differs from all the known members of its family in exhibiting a row of thick scutes along the course of the lateral line. In the latter feature and in the nature of its fin-rays, *Elpisopholis* agrees with the Belonorhynchidæ, and may doubtless be regarded as one of the predicted links between the two families in question. As the fish is almost destitute of scales, its internal skeleton is well displayed, and is proved to resemble in all essential respects the Palæoniscid skeleton, which was first satisfactorily seen in the specimens of *Coccolepis* from the Talbragar River.²

The fragments of *Platysomus* and the supposed *Acentrophorus* from the indurated shale of St. Peter's, are insufficient for discussion, but are interesting as contributing to make the aspect of the new Permo-Carboniferous fish fauna completely familiar, notwithstanding its great distance in space from any corresponding fauna previously discovered.

¹ A. S. Woodward, "The Fossil Fishes of the Hawkesbury Beds at Gosford," Mem. Geol. Surv. N. S. Wales, No. 4 (1890), p. 22.

² A. S. Woodward, "The Fossil Fishes of the Talbragar Beds (Jurassic?)," Mem. Geol. Surv. N. S. Wales, No. 9 (1895), p. 5.

The identifiable fishes of the grey mudstone are distinctly newer in type than those of the black indurated shale, and would be termed Triassic or Rhætic, if found in the northern hemisphere. The only doubtful species is *Palæoniscus antipodeus*, which does not appear to have been seen until now since Egerton originally described it from Cockatoo Island. *Semionotus* is essentially Triassic or Rhætic wherever it be found,—whether in Europe, North America, or South Africa,—and species of this genus occur with *Cleithrolepis* in the grey mudstone at Gosford. *Pholidophorus* is typically Jurassic, but also ranges downwards to the Rhætic and Middle Trias in Europe. The fishes from the St. Peter's mudstone are, indeed, closely similar to those from Gosford, and it is difficult to explain their occurrence on the same geological horizon as those from the black indurated shale already described.

SUPPLEMENTARY NOTE.

THE fish which form the subject of Dr. Smith Woodward's Monograph were collected by Mr. B. Dunstan, F.G.S., Acting Government Geologist of Queensland, from the brick pits of St. Peters, one of the Illawarra suburbs of Sydney.

The clay which is quarried at these pits belongs to the Wianamatta shales, and constitutes the uppermost stage of the Triassic Hawkesbury Series.

The Gosford fossil fish which were described by Dr. Woodward in his previous Memoir were collected from a horizon either at the top of the Narrabeen stage—which is separated from the Wianamatta by a thickness of from nine hundred to one thousand feet of Hawkesbury Sandstones—or at the base of the Hawkesbury Sandstone itself.

As Dr. Woodward has pointed out, the fish are found in two types of matrix, a greyish mudstone or shale, and an indurated shale or claystone. There are several bands of this harder rock in the quarries, constituting definite horizons, and separated by the mudstones.

Mr. Dunstan's collection was made at the following pits:—

(a) Gentle's Brick Pit—

Myriolepis pectinata, *Sm. Woodward.*

Elonichthys semilineatus, *Sm. Woodward.*

Palæoniscus antipodeus, *Egerton.*

Pholidophorus australis, *Sm. Woodward.*

(b) Federal Brick Pit—

Pleuracanthus parvidens, *Sm. Woodward.*

Elpisopholis Dunstani, „

Palæoniscus crassus, „

Elonichthys semilineatus, „

Myriolepis pectinata, „

(c) Vickery's Brick Pit—

Pleuracanthus parvidens, *Sm. Woodward.*

Myriolepis pectinata, „

Palæoniscus crassus, „

Acentrophorus, „

(d) Carrington Brick Pit—

Elpisopholis Dunstani, *Sm. Woodward.*

Palæoniscus crassus, „

Elonichthys semilineatus, „

Pleuracanthus parvidens, „

(e) Harper's Newtown Brick Pit—

Pleuracanthus parvidens, *Sm. Woodward.*

W. S. DUN.

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EXPLANATION OF PLATES.

NOTE.—Unless otherwise stated, the figures are of the natural size, and all measurements in the text are given in decimal fractions of the metre.

PLATE I.

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| Fig. 3. Ditto ; tooth, posterior view, four times nat. size. | |
| Fig. 4. Ditto ; tooth, lower view of base, four times nat. size. | |
| Fig. 5. Ditto ; tooth-cusp, side view, four times nat. size. | |
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| Fig. 8. Ditto ; base of pectoral fin, two-thirds nat. size. <i>mtp.</i> , metapterygium ; <i>pr.</i> , preaxial rays. | |

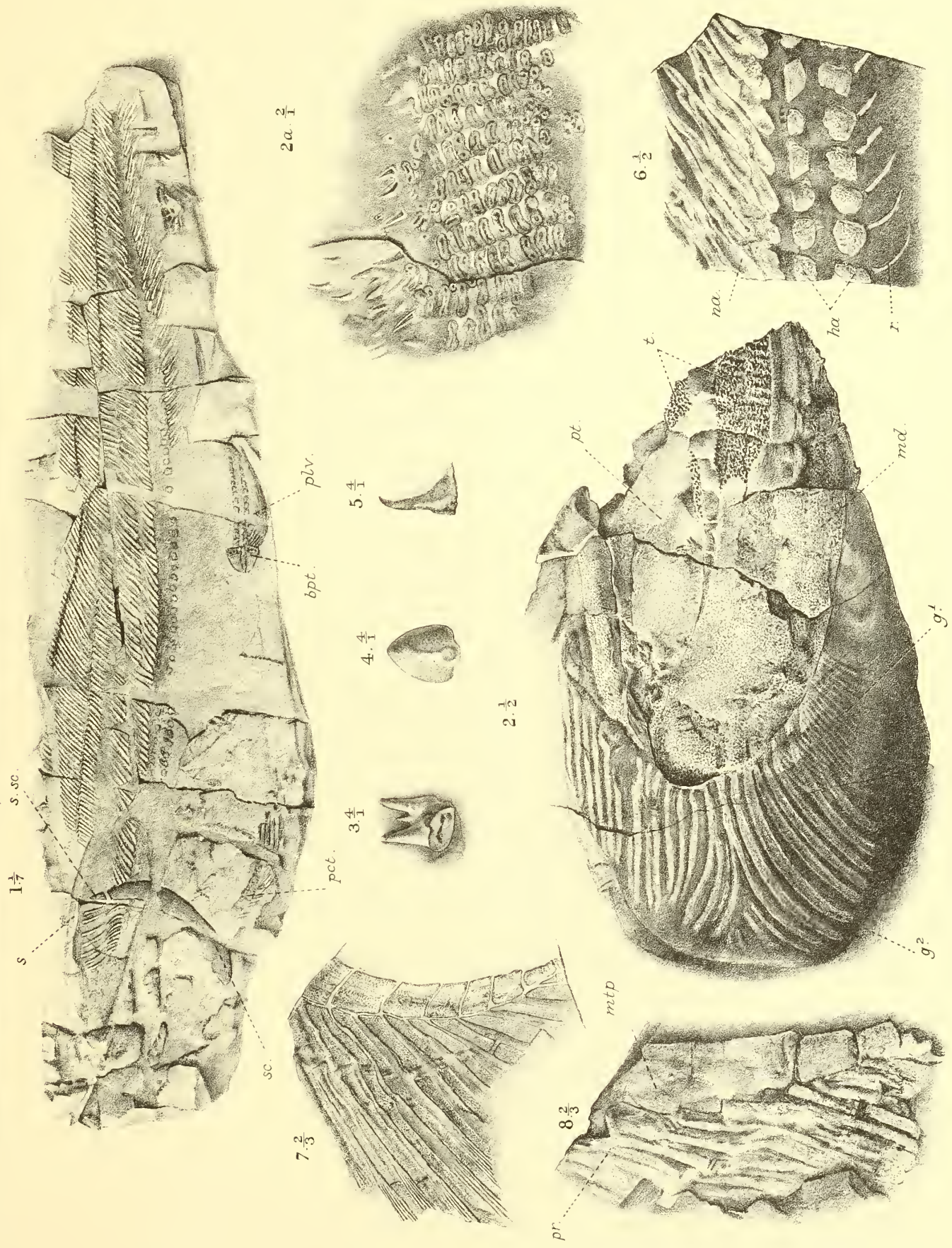


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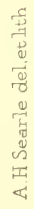
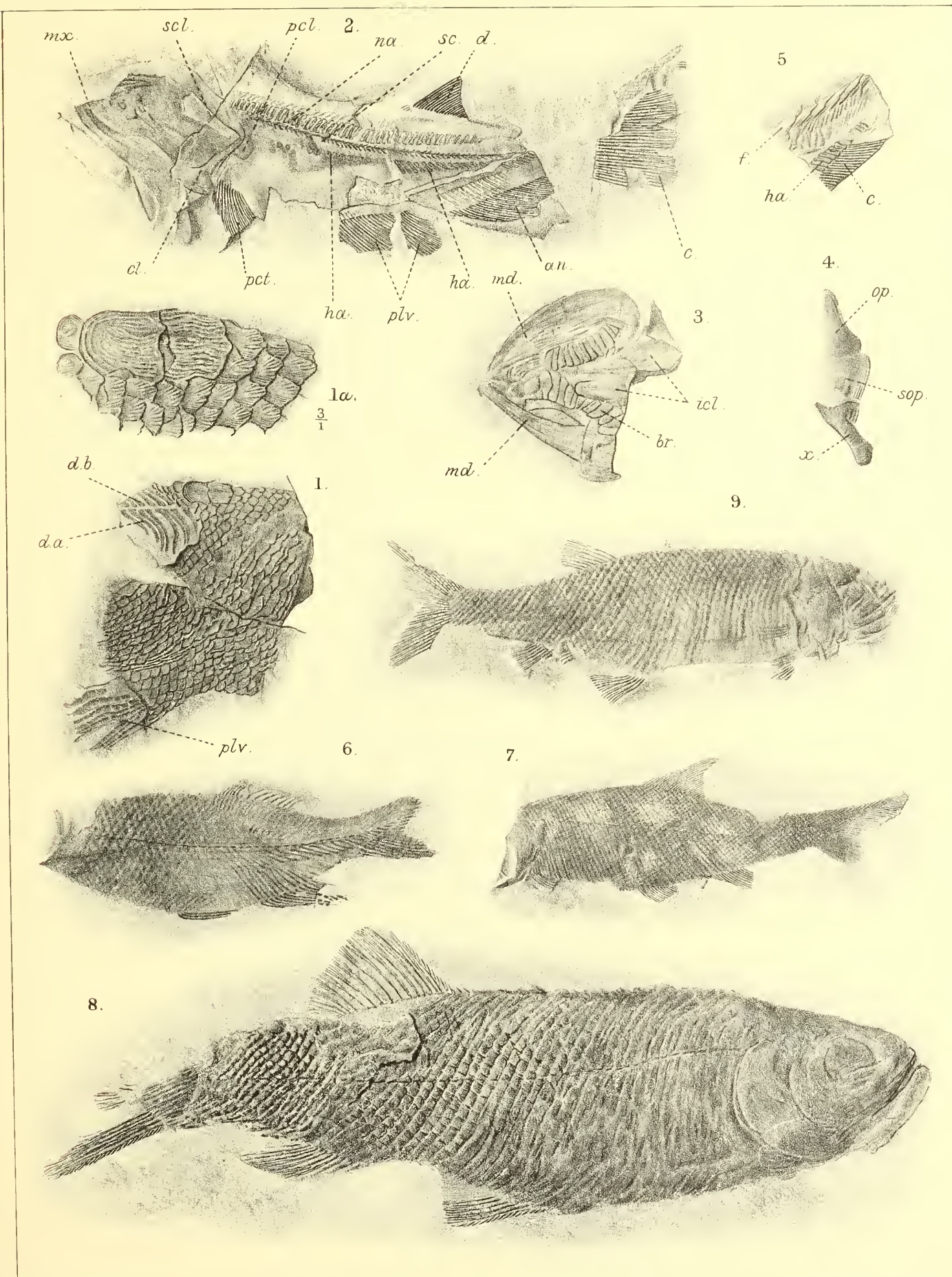


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A H Searle del ethh

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1. ELONICHTHYS. 2-5. ELPISOPHOLIS. 6. ACENTROPHORUS (?)
 7. PALÆONISCUS (?). 8. SEMIONOTUS. 9. PHOLIDOPHORUS.



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